

APPENDIX C
ELECTRICAL SPECIFICATION

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TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
C1.0	SCOPE	C1.1
C2.0	GENERAL REQUIREMENTS	C1.2
C2.1	Site Requirements	C1.2
C2.2	Utility Power	C1.2
C2.3	Codes and Standards	C2.2
C2.4	Applicable Documents	C2.1
C3.0	EQUIPMENT AND MATERIAL	C3.1
C3.1	General	C3.1
C3.2	Specific Site Requirements	C3.1
C3.3	Cable Conduit (Cable way) and Fittings	C3.1
C3.4	Wire and Cable	C3.2
C3.5	Lighting Fixtures, Receptacles, and Switches	C3.2
C3.6	Grounding System	C3.2
C3.7	Service Disconnect Switch	C3.3
C4.0	INSTALLATION	C4.1
C4.1	General	C4.1
C4.2	Temporary Light and Power	C4.1
C4.3	Equipment Shelters and Radome	C4.1
C4.4	Grounding System	C4.1
C4.4.1	Ground Cable Sleeves	C4.3
C4.5	Underground Conduit	C4.4
C4.6	Above Ground Conduit	C4.4
C4.7	Wire and Cable	C4.5
C4.8	Nylon Pull Rope	C4.6
C4.9	Service Disconnect Switch	C4.6
C5.0	TESTING	C5.1
C5.1	General	C5.1
C5.2	Insulation Tests	C5.1
C5.3	Equipment Tests	C5.1
C5.4	Operational Tests	C5.1
C5.5	Grounding Tests	C5.2

C1.0 SCOPE

This Specification describes site electrical requirements including power, grounding, site lighting, interconnections, and cabling.

C2.0 GENERAL REQUIREMENTS

All electrical work shall be completed in accordance with Contractor prepared and Government approved site drawings. Government approval of site drawings shall not relieve the Contractor of meeting Specification requirements.

C2.1 Site Requirements

All equipment, materials and systems shall meet the requirements specified on approved site drawings and in this Specification.

On-site handling of all required electrical equipment and materials shall comply with the manufacturer's recommended installation and operating procedures.

Lightning protection air terminals, down leads to the base of the tower, and a conduit support mast with cross struts shall be required.

C2.2 Utility Power

Approved site drawings shall identify the requirement for 208 volt, 3-phase, 60 Hz power supplied from a transformer which shall be provided by the local utility company. Conduit shall be required up to the interface point and shall be coupled to the incoming conduit.

A feeder cable shall be required up to the transformer which supplies power to the radar site; the feeder cable shall be properly terminated.

A fused disconnect switch shall be installed; it shall be permanently labeled as suitable for use as a service disconnect. (For more details, see sections C3.7 and C4.9 of this Specification). A pedestal for mounting of this switch shall be required.

C2.3 Codes and Standards

This section lists all the applicable documents referenced elsewhere in this Specification. The current issue of the following documents, together with their first tier references, form a part of this Specification to the extent specified herein. Unless specifically stated otherwise, the version of the document that applies is the version in effect on the date of issue of the solicitation.

C2.4 Applicable Documents

This section lists all the applicable documents referenced elsewhere in this Specification. The current issue of the following documents form a part of this Specification to the extent specified herein. Unless specifically stated otherwise, the version of the document that applies is the version in effect on the date of issue of the solicitation.

The following documents are available from the sources shown. The work, equipment and materials shall be in compliance with the codes and standards listed below.

- a. All State and Local Codes as apply to the installation site;

Source: Applicable state and local agencies

- b. National Electric Code (NEC);

Source: Institute of Electrical and Electronics
Engineers, Inc.
Operations Center, Customer Service
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
1-800-678-4333

Internet:

<http://standards.ieee.org/catalog/nec.html>

- c. Underwriter's Laboratories (UL); and

- (1) Electrical Materials List
- (2) UL 1 Flexible Metal Conduit
- (3) UL 6 Rigid Metal Conduit
- (4) UL 360 Liquid-Tight Flexible Steel Conduit
- (5) UL 1242 Intermediate Metal Conduit

Source: Global Engineering Documents
Customer Support A105
15 Inverness Way
Englewood, CO 80112
1-800-624-3974

Internet:

<http://ulstandardsinfonet.ul.com/>

<http://global.ihs.com/>

d. Department of Defense

MIL-STD-188-124B Grounding, Bonding and Shielding

MIL-HDBK-419A Vol. I and Vol. II, Grounding,
Bonding and Shielding

Source: Defense Automation and Production Service
Building 4/D
700 Robbins Avenue
Philadelphia, PA 19111-5094

Internet Address:

<http://astimage.daps.dla.mil/quicksearch>

C3.0 EQUIPMENT AND MATERIAL

C3.1 General

All equipment and materials shall be new, as described below, and as described on the approved site drawings. Substitutions must be approved by the Government.

Plastic straps shall not be used where exposed to the outside ambient.

C3.2 Specific Site Requirements

Government approved site drawings shall specify requirements for the following areas:

- a. Ventilation, temperature control and monitoring, and heating/cooling for equipment shelters and the radome;
- b. Security system for the radome, the front gate, and the shelters;
- c. Site surge protection;
- d. Aircraft warning light;
- e. Wiring diagram and location of junction boxes; and
- f. Fire/smoke detection system for shelters.

C3.3 Cable Conduit (Cable way) and Fittings

When underground conduit is used, the following requirements shall apply:

- a. Underground communications conduit - rigid steel galvanized;
- b. Underground telephone conduit - rigid steel galvanized; and
- c. Underground power conduit - rigid steel galvanized.

When above ground conduit is used outdoors, inside the radome, or inside the shelters, the following requirements shall apply:

- a. Galvanized steel Intermediate Metal Conduit (IMC), liquidtight flexible metal conduit (UL Listed Type UA), and flexible galvanized steel conduit.

The conduit fittings, condulets, pull fittings, etc., shall be Crouse-Hinds or approved equal, and appropriate for the application. In addition, for outdoor duty, they shall be gasketed.

C3.4 Wire and Cable

Wire and cable shall be as follows:

- a. For underground 120/208 Volt service the cable shall be single conductor, copper, 600 Volt rated type USE/RHH-RHW;
- b. For above ground power and control the cable shall be single conductor, copper, 600 Volt rated Type THHN or THWN;
- c. Lighting fixture shall be copper, Type SF, 300 Volt rated; and
- d. For analog signals, the cable shall be single pair copper, twisted, shielded, #16 AWG, 300 Volts, with an overall cover.

C3.5 Lighting Fixtures, Receptacles, and Switches

Lighting fixtures shall be required for all shelters and for the radome. The fixtures shall be supplied with lamps, stems, boxes, all hardware necessary to meet NEC requirements, wired, assembled and ready for operation.

C3.6 Grounding System

A complete grounding system meeting the requirements of MIL-STD 188-124B shall be installed and tested. The grounding system shall act as a combined ground for the electrical and electronic systems, lightning protection system, and personnel safety.

C3.7 Service Disconnect Switch

Approved site drawings shall indicate the installation and connection requirements for a 200A minimum service disconnect switch in accordance with this Specification. The 200A minimum service disconnect switch shall be installed as required by the approved site drawings.

C4.0 INSTALLATION

C4.1 General

Approved site drawings shall indicate the requirements for the assembling, testing, installing, and connecting of all equipment, to include instructions received with the equipment, and in accordance with the Specifications, as well as in accordance with state and local code. All equipment shall be assembled, tested, installed, and connected in accordance with the approved site drawings.

C4.2 Temporary Light and Power

Temporary electric service used during the construction phase shall be grounded in accordance with the NEC. Temporary electric service shall be removed at the completion of the construction phase or when otherwise directed by the Government.

C4.3 Equipment Shelters and Radome

Approved site drawings shall identify all power, control, and instrumentation interconnections. All power, control, and instrumentation shall be interconnected in accordance with the approved site drawings.

C4.4 Grounding System

A complete underground grounding grid along with copperclad grounding rods, grounding cables, and a ground test well that meets the requirements of MIL_STD_188-124B utilizing MIL-HDBK-419A shall be required at the radar site. The grounding grid acts as a ground for the electrical system and provides a ground loop for the radome lightning protection system.

The ground cable from the ground loop, at two locations, shall be extended into the auxiliary power source (generator), connecting one extension to the auxiliary power source base and the other extension to the main utility breaker (225A minimum) ground terminal. Any tie between the utility main breaker ground and neutral terminals shall be disconnected.

The ground cable from the ground loop at one location shall be extended into the equipment shelters, terminating it at the telephone demarcation panel ground bus. The supplied demarcation panel ground bus shall be Gould-Shawmut P/N 66081 or approved equal. The ground bus shall be located immediately inside the shelters at the ground penetration point, and on the same wall as the telephone demarcation panel.

The ground conductor entering the equipment shelters main distribution panel in conduit (together with the power conductors) shall be connected to the ground bus.

The radome tower shall be provided with lightning rods and down conductors which shall be installed and connected to the pigtails at the base of the radome. Pigtails are to be furnished as part of the site grounding requirements of this Specification.

The tower stairway or ladder shall be grounded using a #4/0 bare copper stranded cable Cadwelded to the stairway or ladder and connected to the center mast ground cable.

All installed electrical items such as raceways, lighting fixtures, enclosures, and incoming power system neutral and ground wires, shall be grounded in accordance with the NEC and all state and local codes.

The perimeter fence and its supporting post and top rail wires shall be electrically conductive material and shall be grounded as indicated on the approved site drawings and in accordance with Appendix E - Fence Specification. A stranded bare copper wire conductor shall be threaded through the entire length of the fence. The stranded bare copper wire conductor shall be bonded to each fence post and to ground at the corner fence posts; this bond connection shall be described in the approved site drawings.

All connections of ground cables to fence posts done by exothermic (Cadweld) process shall be finish brush coated using the Cadweld T358 Regalv product or equivalent.

The ground cable shall be laid in trenches below the frost line. The trenches shall be excavated and the cable shall be laid with slack and the trenches backfilled with clean, thoroughly compacted earth, free from rocks or stones. The ground cable shall not be kinked or damaged by rough handling or dragged over rock or earth.

The ground rods shall be installed in accordance with MIL-STD-188-124B using the guidelines of MIL-HDBK-419A.

Except as otherwise noted in the approved site drawings, all the below grade connections in grounding cables and between cable and the rods shall be done by the Cadweld process. Where ground wires cross each other, they shall be connected together by the Cadweld process. Above ground connections or splices shall be made either by the Cadweld process or by mechanical or compression connectors. Compression connectors shall be applied using hydraulic compression tools.

The instructions of the manufacturer shall be followed closely while making the Cadweld connections. All joints shall be checked and inspected for good fusion before being covered. The conductors shall be thoroughly cleaned before connection.

Above ground cable runs shall be run close to the surface and shall be properly clamped. They shall be fastened at 3 foot intervals, without slack, using stainless steel straps or clamps as specified on the approved site drawings. Connections to equipment shall be by means of lugs. Lockwashers shall be used for securing the connections.

Each mechanical or compression grounding connection shall be made in the following sequence:

- a. Clean the bonding surface to bare, clean metal;
- b. Coat the bonding surfaces with No-Ox-Id as manufactured by Sanchem, Inc., or approved equivalent;
- c. Assemble the connection, via proper torquing or compression (as required);
- d. Repair any previously painted surface by suitable paint application, where required; and
- e. Coat the exposed surfaces of the grounding connection liberally with No-Ox-Id.

The conduit system shall be electronically continuous and shall be properly grounded at each enclosure.

C4.4.1 Ground Cable Sleeves

Schedule 40, PVC conduit sleeves shall be required for ground cable penetrations in sidewalk locations.

- a. 1" PVC for #4/0 bare or insulated copper ground cable;
- b. 1-1/4" PVC for 250 MCM insulated copper ground cable (as required); and
- c. 1-1/2" PVC for 500 MCM insulated copper ground cable (as required).

C4.5 Underground Conduit

When underground conduit is used, it shall be of the direct burial type. The conduit shall be buried below the frost depth. The trench, after laying conduit, shall be backfilled and compacted as specified in Appendix B - Site Preparation. Conduit trench shall have a detectable tape buried on top of the conduit, as shall be specified in the approved site drawings. The tape shall be Reef Industries P/N 0531415 for the power conduit and Reef Industries P/N 0531116 for the communication lines conduit, or approved equivalent.

Conduits, routed through the slab, shall be installed prior to installation of concrete; the approved site drawings shall identify the actual locations of these conduits. Any additional cutting found necessary shall be accomplished, and openings shall be patched to match the original conditions.

Where conduit passes through a sleeve, the space between the sleeve and the conduit shall be air-tight and fireproof using non-shrink grout.

To prevent passage of air, gas, or water and to inhibit passage of smoke or flame, conduits which are routed through shelter floors or which enter the main electrical panel in the equipment shelters from below shall be sealed with caulk of 3M type CP25S/L or equivalent.

All other openings shall be sealed with adhesive sealant GE Silicone RTV167, as shall be indicated in the approved site drawings.

Changes in direction of underground conduit shall in general, be made using wide sweeps. Standard small radius bends shall be used only for exiting from the slab.

C4.6 Above Ground Conduit

Conduit runs as indicated on the approved site drawings shall be diagrammatic only. Conduit runs shall be fitted to field conditions to avoid interferences. For conduit 1.5 inches and smaller, field bends shall be used while factory bends shall be used for larger size conduit. The bending radius shall not be less than that specified in the NEC.

Conduit runs above ground shall be supported at intervals not to exceed 8 feet. Conduit supports and hardware shall be either hot dipped galvanized or approved equivalent. All conduit runs shall be securely fastened in place using appropriate fittings, flat washers, spring lock washers and nuts, where applicable, and shall be secured to masonry by expansion anchor bolts, and to metal surfaces by bolted clips.

Those conduits which penetrate the top of the tower foundation shall have their extension above the top of the foundation set to 2 inches.

All conduits which penetrate the floor of any shelter shall be installed to requirements as shall be indicated on the approved site drawings.

All joints in rigid metal conduit shall be threaded using standard couplings. All joints shall be made tight to assure maintaining the ground continuity in the system. All the cut threads shall be coated with a thread sealant. Where galvanizing is damaged, it shall be repaired by the application of galvanizing paint. Conduit connections to boxes and cabinets shall be made with double locknuts and an insulated bushing, or by connection to a suitable conduit hub, as applicable. All the boxes and enclosures shall be securely fastened to the steel structure.

All rigid conduit ends shall be reamed and grounding bushings shall be installed where entering an enclosure, or terminating conduit runs. Grounding bushings shall then be connected to ground. Pull fittings or pull boxes shall be provided to facilitate the cable pulling, as needed.

When flexible conduit terminates at equipment, appropriate fixed terminating fittings and bushings shall be provided.

Horizontal conduit runs external to the shelters shall slope downward from the equipment shelters to the waveguide conduit drains to preclude moisture buildup.

C4.7 Wire and Cable

Prior to pulling of cables, the interior of all conduit and raceways shall be cleaned. The conduit ends shall be free of any burrs and sharp edges. The cable pulling shall be done as to avoid damage to the cables.

Cables with end connectors shall be pulled in a direction and manner to enable the installation and under no circumstances shall connectors be removed or cut off to facilitate the cable pull.

Where several cables are pulled in the same conduit, they shall be pulled together. Woven basket grips shall be used where the maximum tension is less than 1000 lbs, and a pulling eye shall be

used when the maximum tension is higher than 1000 lbs. Rope hitches shall not be used.

Cable pulling compounds or lubricants shall be used in accordance with the cable manufacturer's recommendations. Cable pulling tension and side wall pressure shall not exceed the values given by the manufacturer.

C4.8 Nylon Pull Rope

All communication and power conduit runs within the site, plus those entering the site from outside, shall be provided with a 3/8" diameter nylon pull rope for later use. Rope shall be the length of the conduit run with an additional exposed length of 10 feet on each end and shall be anchored at both ends.

C4.9 Service Disconnect Switch

Approved site drawings shall indicate the installation and connection requirements for the service disconnect switch in accordance with this Specification. The switch shall be installed with the following connections made within the switch:

- a. The incoming ground conductor shall be connected to the ground bus;
- b. The incoming neutral conductor shall be connected to the neutral bus;
- c. The ground bus shall be connected to the neutral bus via a #4/0 AWG conductor;
- d. The ground bus shall be bonded to the switch via a #2 AWG conductor; and
- e. The neutral bus shall be connected to the external ground grid system via a #4/0, type USE cable.

A notice that an on-site auxiliary power generating source exists shall be affixed externally to the service disconnect switch.

C5.0 TESTING

C5.1 General

Instruments and test equipment used for testing shall be in calibration. The Government shall have the right to witness all tests. Materials, equipment, devices or workmanship not in conformance with specified requirements shall be promptly replaced with materials, equipment, devices, or workmanship that conform with specified requirements.

C5.2 Insulation Tests

Insulation resistance tests shall be made on all electrical equipment, and on cables rated 600 volts or less. Direct current potentials used in these tests shall be as follows:

Normal Operating Voltage (Volts)	Test Voltage (Volts)	Minimum Insulation Resistance for one Minute (Megohms)
Up to 100	500	0.5 (<1mA)
101 to 600	1000	1.0 (<1mA)

C5.3 Equipment Tests

Continuity tests shall be performed on the wire and cable for all systems.

The primary and auxiliary power sources shall have the same phasing. A phasing test shall be performed on the auxiliary power system to assure the same phasing as the primary power source.

All rotating machinery shall be checked to assure correct rotation.

Control circuits shall be validated for agreement with wiring diagrams or detailed descriptions.

C5.4 Operational Tests

Upon completion of the installation of individual systems and at such time as designated by the Government, operational tests on installed equipment and systems

shall be performed. The Government shall have the right to witness all operational tests. Operational tests shall be conducted for the purpose of demonstrating that the equipment and systems comply with Specification requirements and to demonstrate that all equipment and circuits function properly.

C5.5 Grounding Tests

Ground resistance measurements, parallel to the two site diagonal lines, shall be made using the ground grid test well as the connection point to the ground grid; such measurements shall be made upon completion of the entire grounding system at the site and prior to: the installation of any shelters; the connection to the tower ground cables; the connection to the ground cables from the shelter sites and backfilling at that location; and the making of connections to above ground equipment. Testing shall be accomplished by a person thoroughly experienced in the use of test instruments required for these tests. The Government shall have the right to witness all ground grid tests.

The procedure to be followed in the measurement of the ground resistance shall be the three-point fall of potential method in accordance with Paragraph 2.7 of MIL-HDBK-419A (Volume 1 of 2 Volumes).

If the 62% Resistance Value measured along either of the site diagonal lines is greater than 10 ohms, the condition shall be reported to the on-site Government representative for further direction.

Measurements shall be made with the Biddle Instruments *Megger* earth tester, Associated Research *Vibroground* or approved equivalent. Approved site drawings shall indicate electrode distances.

In addition, each ground riser shall be checked for resistance to the ground test well. If any ground riser resistance measurements are over one ohm, the on-site Government representative shall be contacted for further direction.

The fall of potential tests and ground riser resistance measurements shall be performed on the same day.